International Journal of Environment, Ecology, Family and Urban Studies (IJEEFUS)
ISSN (P): 2250–0065; ISSN (E): 2321–0109
Vol. 12, Issue 1, Jun 2022, 41–50

SANITARY SURVEY OF WELLS IN EKITI STATE, SOUTHWESTERN NIGERIA: IMPLICATIONS ON GROUNDWATER QUALITY

TALABI, A. O

Ekiti State University, P. M. B. 5363, Ado-Ekiti, Nigeria

ABSTRACT

It is increasingly becoming difficult to access potable water in Ekiti State, Southwestern Nigeria due to poor sanitation and unhygienic practices. Ten (10) sanitation and hygiene factors that may lead to contamination of groundwater were accessed in eighty eight (88) wells from the study area with a view to observe if the survey can be a substitute to hydrochemical and microbial evaluations of the groundwater. Data obtained from the survey were subjected to statistical evaluation and graphical plots using Microsoft Excel. The result was subsequently classified into very high (90 to 100%), high (60 to 80%), intermediate (40 to 50%) and (0 to 30%) as low. The result of the sanitary survey revealed that the contamination risk values ranged from 0 – 50% falling in the low to intermediate classes of risk classification. Over 80% of the sanitary survey in the area fell into low risk class while <20% were in the intermediate category. No sanitary survey results in the high and very high classes of risk classifications showing that the groundwater in the study area was relatively free from contamination and safe for consumption. This observation was supported by previous work in the area which indicated that groundwater was low mineralized with limited water–rock interactions. However, groundwater in the area has been found to be contaminated bacteriologically an indication that the groundwater was not potable. The sanitary risk survey can serve as a quick check on the hygienic situation of groundwater but it cannot replace hydrochemical and bacteriological evaluations of the groundwater as previous research from the area revealed low mineralized water that has been infected bacteriologically.

KEYWORDS: Potable Water, Sanitation and Hygiene Factors, Contamination, Sanitary Survey & Mineralized Water

Original Article

Received: Dec 03, 2021; **Accepted**: Dec 23, 2021; **Published**: Jan 29, 2022; **Paper Id.**: IJEEFUSJUN202205

1. INTRODUCTION

Safe water is essential for the continual sustenance of human health. Health-related problems are often consequent of contamination of water. Groundwater can be contaminated/polluted through geogenic and anthropogenic activities. The anthropogenic activities control the sanitary system (survey) of any society. Most pollutants are from poor management of on-site sanitation systems, sewage and sewage sludge as well as rubbish dump leachates. Sanitation refers to public health conditions related to clean drinking water and 'treatment and disposal of human excreta and sewage [1]. Preventing human contact with feces is part of sanitation, as is hand washing with soap [2, 3]. Lack of sanitation usually means lack of toilets or lack of hygienic toilets that anybody may want to use voluntarily. The result of lack of sanitation is usually open defecation (and open urination but this is of less concern) with associated serious public health issues [4].

Groundwater can be contaminated by design, accident or through neglect. Neglect arising from the care free attitude of humans towards sanitation and hygiene practices are most prevalent, especially in rural settings. A Sanitary survey entails evaluating our physical environment with a view to identifying possible health hazards and

sources of environmental contamination. Sanitary surveys are a comprehensive inspection of the entire water delivery system from the source to the mouth and are, therefore, the best means of identifying potential problems and changes in the quality of drinking water. Sanitary surveys, which are observational checklists to assess hazards present at water sources, are simpler to conduct than microbial tests [5]. Sanitary surveys can be completed quickly and require no special equipment, making them less expensive and easier to implement than microbiological testing [6]. It is estimated that 2.4 billion people still lack improved sanitation facilities including 660 million people who lack access to safe drinking water as of 2015 [7].

Previous research work from the study area (Ekiti State Nigeria) revealed that open defecation is still operational in some parts of the area. The research on Bacteriological Evaluation of Groundwater in Ekiti-State, Southwestern Nigeria [8] revealed that virtually all groundwater samples tested positive to bacterial contamination arising principally from surface phenomena of improper disposal of wastes and human faeces. The study has it that correlating sanitary survey with microbial water quality test produced mixed results. Research from County Cork, Ireland, though with few contaminated samples, revealed no correlation between sanitary survey–identified hazards and thermotolerant coliform (TTC) [9]. In contrast, a study in Dar es Salaam, Tanzania, showed that 87% of the measured ***Escherichia coli*** concentrations of wells in the area could be predicted from their sanitary scores [6]. Despite the observed shortcomings of the sanitary survey, information about the quality of rural drinking water sources can be deviously obtained and used to manage their safety and mitigate risks to health [5, 9].

This study therefore aimed at the Sanitary Survey of Wells in Ekiti State, Southwestern Nigeria with a view to evaluating the dare consequences on groundwater quality using existing water quality research in the area.

2. LOCATION OF STUDY

Ekiti State is one of the thirty six states in Nigeria with a population of 2,384,212 [10].(NPC, 2006). It is located between longitudes 4°48′ and 5°30′ East of the Greenwich meridian and latitudes 7°25′ and 7°52′ North of the Equator with a total land area of 4,344km^2 [11] (Figure 1). The area is an upland region with elevation generally above 250m above sea level.

The area enjoys a tropical rain forest climate with distinct wet and dry seasons. The dry season spans from November to April while the wet season is between May and October. The mean annual rainfall is about 1700mm while the mean monthly temperature and relative humidity are 29˚C and 75% respectively [12].

2.1. Geology and Hydrogeology of the Study Area

The study area is part of the Basement complex of southwestern Nigeria and almost all the sequences of rocks present in the southwestern basement terrains are found in Ekiti State. Geologically, Ekiti state comprises of crystalline rocks mainly migmatite-gneiss-quartzite complex, quartzite, psamitte, older granites and charnockites (Figure. 1). The older granites and chrnockites have ubitiqous occurrence. The migmatite is the oldest rock in the area (2.0 – 3.0 Ga) [13]. The migmatite is the most abundant rock with about 65% coverage of the terrain. It has suffered many tectono thermal events that have brought rocks of various origins together [14]. Prominent in the area are banded gneiss, migmatite gneiss and granite gneiss. The granite gneiss is heterogeneous having the metamorphosed portion and the granitic portion with varying textural characteristics [15]. Mineralogically, the rock displays felsic minerals including quartz, feldspar and mica with some accessory minerals such as Myrmikite. The rock also displayed varieties of structural elements such as folds, cracks, folded quartz-veins and foliations. The migmatite gneiss are low lying outcrop of medium to coarse grained texture and

with mafic and felsic bands defined by biotite, hornblende and other ferromagnesian minerals [15]. The banded gneiss is a metamorphic rock with alternating mafic and felsic minerals.

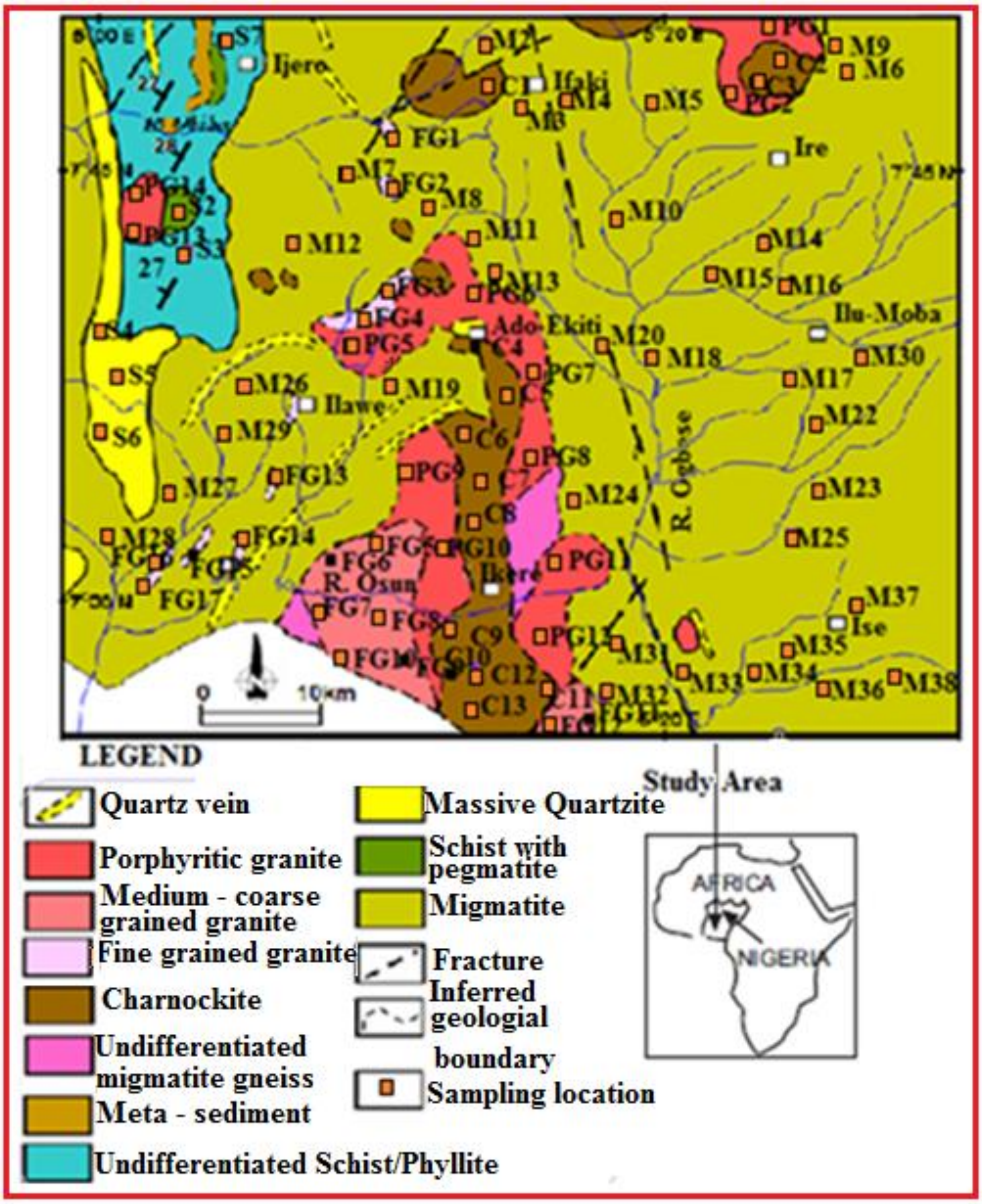

Figure 1: Geology Map of the Study Area Indicating Surveyed Wells Modified After [11].

The granites were emplaced in close association with the charnockites during the Pan-African orogeny. The granites are distinguishably unique because of their visible minerals, lack of foliation, fine-medium grained texture and compact interlocking crystals that developed during the crystallisation of magma. Granitic rocks of porphyritic texture occur around Ado-Ekiti, Ikere-Ekiti and close to Ikole-Ekiti. Some of the outcrops occur as well-rounded boulders devoid of any preferred orientation of component minerals. Some of the rocks form prominent high rising inselbergs at Ikere-Ekiti in the southern part of the study area. The Psammite is found in Efon Alaye area and is often referred to as Efon Psammite. The Efon Psammite is a NNE-SSW trending highly foliated, jointed, schistose ridge often showing interesting sedimentary structures [16]. Psammite represents metamorphosed rock with sandstone protolith.

The hydrogeology of the area is controlled by its climate, the underlying rock units as well as its structures. Both the surface water and groundwater constitute the hydrogeology of the study area. The major surface water in the study area are rivers Ogbese, Osun, Oni, Ose and

Ero and their tributaries [17]. Rainfall plays a vital role in groundwater occurrence in the study area. Two main seasons occur in the area with the rainy season experiencing high rainfall and the intensity of groundwater recharge is always high being a function of precipitation. It was reported by [18] that wells dug close to the river normally contain water at shallow depth. However, the water table falls progressively in the dry season with the amount of fall determined by the location of the well from the river. Generally, the closer a well is to the river channel, the smaller the fall. The study area is covered with crystalline rocks that are non porous and non permeable except when they are fractured or weathered so that there will be thick overburden to hoist water. As the concept of interstices – open spaces that form receptacles and conduits for groundwater, their origin, shape and interconnection, is fundamental to groundwater occurrence in the study area. The types and origin of openings, therefore, may be considered to be a basis for the groundwater occurrence in the area. Primary aquifer is of no consequence in the basement terrain of Ekiti State. However, the area consists mainly of secondary aquifers in which groundwater occur in secondary openings which originate from processes that affect rocks after they were formed. The secondary openings are in terms of joints, cleavages, bedding planes, faults and pores resulting from the disintegration, decomposition and dissolution of rocks. The processes are tectonic deformation, weathering and unloading by degradation of the land surface. In this terrain surface runoff is high and groundwater occurrence is erratic. In most situations, the rocks that are heterogeneous in distribution controls the occurrence of groundwater apart from weathering intensity. Most groundwater occurrence is tapped from the thick overburden weathered rocks in the area. Most of the inhabitants tapped the resources by construction of hand dug shallow wells with few boreholes. The crystalline rocks, generally in their unaltered form, are characterized by low porosity and permeability. Porosity in the basement rocks is by induction through weathering while secondary permeability induced by tectonic activities served as paths that facilitate water movement. In other words, aquiferous zones in the Ekiti-State basement terrain include fractured/weathered rocks. Groundwater occurs in the basement complex either in the weathered mantle or in the joints and fractured systems in the fresh rocks and buried stream channels [19, 20]. The highest groundwater yield in the basement terrain is found in areas where thick overburden overlies fracture zones [21]. Demographic records in the area of the study revealed that the groundwater recharge from the rivers is about 250mm, while rainfall infiltration accounts for a much higher amount of 1000mm. The rock units have low primary porosity and hydraulic conductivity. Two major aquiferous units have been identified to be the weathered overburden and fractured layers. Boreholes yield as reflected in Benin/Owenna River Basin authority records ranges from 0.31-10L/s. The 10L/s occurred at Ikere-Ekiti artesian well.

3. METHODOLOGY

Eighty eight wells were randomly selected from the study area for the sanitary survey exercise (Fig.1). The sanitary survey processes in accordance with [22] were adopted in this research. Modifications to questionnaires were made where necessary to suit the local situations of the area. At each well, prepared questionnaires were admitted and answers in form of yes or No were provided. Subsequently, a critical look at the answers were undertaken to arrive at the risk score. Critical look at the answers became imperative as both yes and no may constitute a risk e.g. Is the well covered?. “No” to this type of question constitute a risk whereas yes indicates no risk. On the other hand, a well that is fetched using a bucket and rope will have a yes response and in this response, yes answer constitutes a risk. A score of one point was awarded for each

"yes" or "no" answer that constitutes a risk and zero point for each "no" or "yes" answer that indicates a no risk observed. By summing all the scores for which risks are observed a final risk score was obtained which provide the overall assessment of the risk profile of each well. The total sanitary risk score was converted to a percentage while the aggregate risk score was graded as very high (90 to 100%), high (60 to 80%), intermediate (40 to 50%) and (0 to 30%) as low in agreement with [6] research on sanitary inspection of wells using risk-of-contamination scores. Data obtained from the survey were subjected to statistical evaluation and graphical plots using Microsoft Office Excel 2007. Results of the sanitary survey were compared with some existing research work on hydrochemistry of the study area [8, 11, 23, 24].

4. RESULTS AND DISCUSSIONS

The results of the sanitary survey are presented in Table 1. The result revealed that the risk values in the study area ranged from 0 – 50% falling in the low to intermediate classes of risk classification (table 2). However, based on rock units, charnockite has risk values ranging from 0 – 50% (av. 33.08%) while both the porphyritic granite and fine to medium grained granite have risks falling between 10 and 40% (av. 22.50%). The risk values of schist fall within 20 – 30 % (av. 22.86) (Figure. 2). A critical look at this result (Table 1) revealed that the high risk values are more prevalent in the charnockitic rock while this is closely followed by migmatite risks' values (Figure. 2). Some of these rocks are low lying while a few of them form high rising hills within the study area. There is no plausible reason for the variability in the risks' values based on rock units. However, the settlement of humans may contribute to the difference as the densely populated area is likely to be pruned to pollution due to increased anthropogenic activities. The majority of the wells in the study area (>80%) fall in the low category of risk classification while some (<20%) are in the intermediate class (Figure. 3)

The work of [11] showed that the groundwater system in the study area was low mineralized with limited water–rock interactions. The result of their research supports the low – intermediate classes of risk of groundwater in the study area. However, [8] revealed that the groundwater in the study area is low mineralized fresh water which has been polluted bacteriologically arising principally from surface phenomena of improper disposal of wastes and human faeces. Bacteriological pollution has been the bane of many water-borne diseases in the study area and is not in agreement with the result of the sanitary survey that revealed low – intermediate risk of pollution. Recent work of [24] revealed an insignificant state of pollution of the groundwater in Ado-Ekiti in tandem with the sanitary survey of this present research indicating low to intermediate risk of contamination in the area. It is obvious that the hydrochemical and bacteriological processes of water are dynamic. The sanitary risk survey can serve as a quick check on the hygienic situation of groundwater in the study area. The survey cannot replace hydrochemical and bacteriological evaluation of the groundwater as most research revealed low mineralized water that was infected by bacterial pollutants.

5. CONCLUSIONS

Over 80% of the results of the sanitary survey fell into the low risk class while <20% were in the intermediate category. In terms of rock units, the high risk values are more prevalent in the charnockitic rock while this is closely followed by migmatite risks' values. The sanitary survey of wells in the study area fall into low to intermediate classes of risks' classification indicating an insignificant state of pollution of the groundwater. However, previous work in the area indicated that groundwater in the area is infected by bacterial pollutants. The sanitary survey can serve as a quick check on the quality status of groundwater in the study area but cannot serve as a substitute to hydrochemical and bacteriological assessments of groundwater.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ACKNOWLEDGEMENTS

The author is grateful to some students that participated in administering the questionnaires of this survey.

CONFLICT OF INTERESTS

The author declared that there is no conflict of interest.

Table 1: Data Obtained from Sanitary Survey of Wells in the Study Area

Code	Location	Easting (GPS)	Northing (GPS)	Elevation (m)	Coverd well	Distance to latrine<10m	Animal breeding close to well	Damage apron	Well lined	Conta. rope/ bucket	Rope/ Bucket	Marshy area	Fenced	Stagnant water<2m to well	Total Risk (%)
M2	Aye	512.93	748.09	569	Yes	No	No	No	No	No	Yes	No	No	No	30
M3	Ifaki	514.71	747.44	573	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M4	Ayegbaju	517.53	747.63	545	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M5	Oye	519.65	748.08	568	Yes	No	No	No	Yes	No	Yes	No	Yes	No	10
M6	Igbodo	525.81	748.21	530	Yes	No	No	No	Yes	No	Yes	No	Yes	No	20
M7	Eyio	510.79	743.62	552.6	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M8	Iworoko	515.67	743.83	429	No	No	No	No	No	No	Yes	No	No	No	40
M9	Awo	509	742.85	574.55	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M10	Olora-farm	515.65	742.15	393	No	No	No	No	No	No	Yes	No	No	No	40
M11	Are	517.92	742.58	402.03	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M12	Araromi-iyin	511.64	740.53	437.39	No	No	No	No	No	No	Yes	No	No	No	40
M13	Ilokun	515.19	741.33	403	No	No	No	No	Yes	No	Yes	No	No	No	30
M14	Igbemo	523.43	740.66	384.35	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M15	Abaegbira-elemi	516.32	739.46	427	No	No	No	No	Yes	No	Yes	No	No	No	30
M16	Bolorunduro	520.08	737.41	377.95	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M17	Ilumoba	524.79	738.23	393.8	No	No	No	No	Yes	No	Yes	No	No	No	20
M18	Ijan	523.14	737.42	384.05	Yes	No	No	No	No	No	Yes	No	No	No	30
M19	Erifun	517.25	736.33	374.9	Yes	No	No	No	No	No	Yes	No	No	No	30
M20	Ayoko	518.57	735.98	370.64	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M21	Agoologunja	519.08	736.27	357.23	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M22	Asoajegunle	520.98	737.07	386.18	No	No	No	No	Yes	No	Yes	No	No	No	30
M23	Abaoyan	524.11	735.44	399.9	Yes	No	No	No	Yes	No	Yes	Yes	No	No	30

	Location	Easting (GPS)	Northing (GPS)	Elevation (m)	Covered well	Distance to latrine<10m	Animal breeding /waste dump close to well	Damage apron	Well lined	Conta. rope/ bucket	Rope/ Bucket	Marshy area	Fenced	Stagnant water<2m to well	Total Risk (%)
M24	Ilupeju-ijan	524.34	734.43	378.87	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M26	Abaefon	507.39	732.21	424.89	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M27	Kajola-ise	524.96	732.12	382.52	No	No	No	No	No	No	Yes	No	No	No	20
M28	Igbaraodo	503.75	732.12	370.94	Yes	No	No	No	No	No	Yes	No	No	No	30
M29	Okoisa	517.02	729.11	349	Yes	No	No	No	Yes	No	No	No	Yes	No	10
M30	Abapopoola	518.86	727.34	340	Yes	No	No	No	Yes	No	Yes	No	Yes	No	10
M31	Ogbese	519.37	727.34	309	Yes	No	No	No	Yes	No	Yes	Yes	No	No	30
M32	Ogbese	519.48	727.35	342	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M33	Ogbese	520.24	721.52	305	No	No	No	No	No	No	Yes	No	No	Yes	50
M34	Obada-ise	520.86	727.48	364	Yes	No	Yes	No	Yes	No	Yes	Yes	No	No	40
M35	Ise	524.34	727.87	366	Yes	No	No	No	Yes	No	No	No	Yes	No	10
M36	Ise	525.15	727.83	362	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M37	Orun	525.3	726.93	356	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M38	Orun	526.42	728.54	366	Yes	No	No	No	Yes	No	Yes	No	No	No	20
M39	Abaegbira	525.34	726.48	363	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG1	Itapa	522.86	748.85	626	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG2	Oshin	524.81	748.2	513	Yes	No	No	No	Yes	No	No	No	Yes	No	10
PG3	Ado	513.44	738.92	416.66	Yes	No	No	No	Yes	No	No	No	No	No	10
PG4	Ado	513.25	737.68	437.69	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG5	Ikere	510.45	729.55	392	No	No	No	No	No	No	Yes	No	No	No	40
PG8	Igede	508.16	739.98	561.44	No	No	No	No	No	No	Yes	Yes	No	No	40
PG9	Iyin	509.42	739.6	555.35	Yes	No	No	No	No	No	Yes	No	No	No	20
PG6	Ikere	510.49	729.53	399	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG7	Ikere	513.68	730.04	404	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG8	Eruobodo	515.41	729.65	498	No	No	No	No	No	No	Yes	No	No	No	40

Code	Location	Easting (GPS)	Northing (GPS)	Elevation (m)	Covered well	Distance to latrine<10m	Animal breeding close to well	Damage apron	Well not lined	Conta. rope/ bucket	Rope/Bucket	Marshy area	Fenced	Stagnant water<2m to well	Total Risk (%)
PG9	Eruobodo	516.62	729.4	346	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG10	Ikere	513.22	729.16	370	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG11	Ikere	509.41	728.46	397	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG12	Ikere	512.35	728.94	379.78	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG13	Ikere	513.77	728.83	365	Yes	No	No	No	Yes	No	Yes	No	No	No	20
PG14	Ikere	509.45	728.09	395	Yes	No	No	No	Yes	No	Yes	No	No	No	20
S1	Erio	500.61	743.85	494	Yes	No	No	No	No	No	Yes	No	No	No	20
S2	Erio	500.6	743.83	505	Yes	No	No	No	No	No	Yes	No	No	No	20
S3	Aramoko	502.36	745.42	467	Yes	No	No	No	Yes	No	Yes	No	No	No	30
S4	Aramoko	502.83	742.32	449	Yes	No	No	No	Yes	No	Yes	No	No	No	30
S5	Erijinyan	500.21	736.55	449.28	Yes	No	No	No	No	No	Yes	No	No	No	20
S6	Erijinyan	500.23	736.42	445.62	Yes	No	No	No	No	No	Yes	No	No	No	20
S7	Ikogosi	459.49	735.44	470.31	Yes	No	No	No	Yes	No	Yes	No	No	No	20
FG1	Epe	507.33	746.73	479.45	Yes	No	No	No	Yes	No	Yes	No	No	No	30
FG2	Osi	509.13	747.12	589.48	Yes	No	No	No	No	No	Yes	No	No	No	20
FG3	Araromi-iyin	508.22	746.2	535.23	Yes	No	No	No	No	No	Yes	No	No	No	20
FG4	Ara-ijero	506.49	746.14	393.8	Yes	No	No	No	No	No	Yes	No	No	No	20
FG5	Iropora	509.26	745.33	576.07	Yes	No	No	No	Yes	No	Yes	No	No	No	30
FG6	Igede	507.67	740.03	579.43	Yes	No	No	No	No	No	Yes	No	No	No	20
FG7	Iyin	509.11	739.59	577.59	Yes	No	No	No	No	No	Yes	No	Yes	No	10
FG10	Odo	507.45	736.96	527	No	No	No	No	No	No	Yes	No	No	No	20
FG11	Ilawe	506.45	736.06	432	Yes	No	No	No	No	No	Yes	No	No	No	20
FG12	Ijelu	515.92	736.72	363.63	Yes	No	No	No	No	No	Yes	No	No	No	20
FG13	Ilawe	506.26	735.96	422	No	No	No	No	Yes	No	Yes	No	No	No	40
FG14	Temidire-asa	503.29	734.84	374.9	Yes	No	No	No	Yes	No	Yes	No	No	No	40
Code	Location	Easting (GPS)	Northing (GPS)	Elevation (m)	Covered well	Distance to latrine<10m	Animal breeding close to well	Damage apron	Well not lined	Conta. rope/ bucket	Bucket/ Rope	Marshy area	Fenced	Stagnant water<2m to well	Total Risk (%)
FG15	Kajola-Okuta	502.08	733.66	402.03	No	No	No	No	No	No	Yes	No	No	No	30
FG16	Kajolaoriokuta	502.08	733.66	402.03	No	No	No	No	No	No	Yes	No	No	No	30
FG17	Aba-Alawaye	502.74	733.95	397.76	Yes	No	No	No	No	No	Yes	No	No	No	20
C1	Aba-Oshun	521.26	747.89	616	Yes	No	No	No	No	Yes	Yes	No	No	No	30
C2	Ire	523.53	745.28	516.94	Yes	No	No	No	No	Yes	Yes	Yes	No	No	40
C3	Ire	523.53	745.28	504.75	Yes	No	No	No	No	Yes	Yes	No	No	No	30
C4	Afao	523.59	744.65	557.78	Yes	No	No	No	No	Yes	Yes	No	No	No	30
C5	Ajebandele	512.6	734.41	428	Yes	No	No	No	Yes	Yes	Yes	No	No	No	40
C5	Ajebandele	512.6	734.41	428	Yes	No	No	No	Yes	Yes	Yes	No	No	No	40
C6	Ajebandele	512.63	734.37	409	Yes	No	No	No	No	No	No	No	Yes	No	0
C7	Fagbohun	512.88	732.92	389	Yes	No	No	No	No	No	Yes	No	No	No	20
C8	Obe	512.89	729.92	387.71	No	No	No	No	Yes	Yes	Yes	No	No	No	50
C9	Ikere	513.45	731.33	392	No	No	No	No	No	Yes	Yes	No	No	No	40
C10	Ikere	513.63	730.63	369.5	Yes	No	No	No	No	Yes	Yes	Yes	No	No	40
C11	Ikere	513.7	728.01	383	Yes	No	No	No	Yes	Yes	Yes	No	No	No	40
C12	Ikere	513.69	727.71	367	Yes	No	No	No	No	Yes	Yes	No	No	No	30
C13	Igbole	513.53	748	583.99	No	No	No	No	No	Yes	Yes	No	No	No	40

Table 2: Summary of Sanitary Survey Data in the Study Area

Rock Type	Min	Max	Mean	STDEV
Migmatite	10.00	50.00	24.32	9.29
Porphyritic granite	10.00	40.00	22.50	9.31
Fine grained granite	10.00	40.00	22.50	9.31
Schist	20.00	30.00	22.86	4.88
Charnockite	0.00	50.00	33.08	12.51

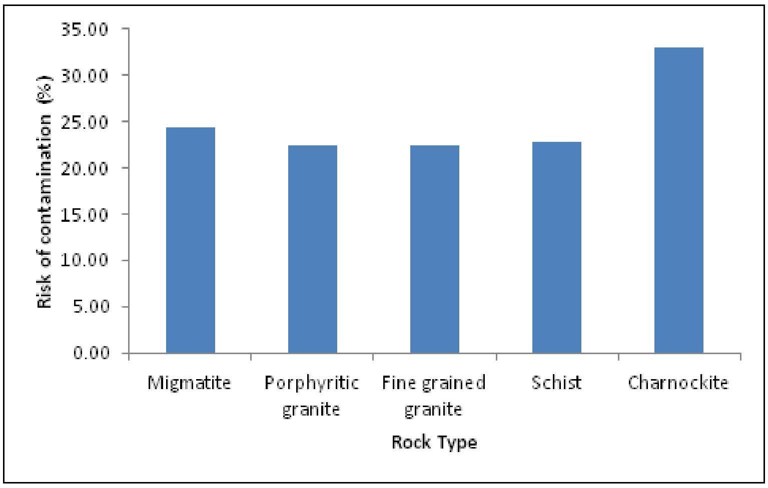

Figure 2: Risk Classification of Groundwater in the Study Area base on Rock Units.

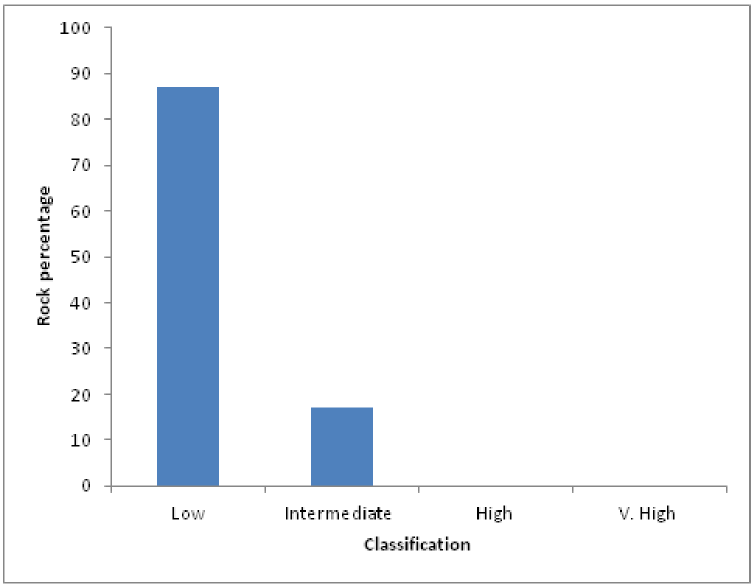

Figure 3: Risk Level Classification of Groundwater in the Study Area.

REFERENCES

1. *Oxford, Dictionaries. 2021. "Sanitation|Definition of sanitation in English by Oxford Dictionaries". Oxford Dictionaries | English. Retrieved 2021-11-5.*

2. *Talabi, A. O. 2018. "Estimated volume of water in shallow wells of Ekiti State, Southwestern Nigeria: implications on groundwater sustainability". Arab J Geosci. 11:1-9 DOI 10.1007/s12517-018-4031-3.*

3. *Talabi, A. O. 2021. "Study on the Role of Safe Water in the Control of COVID-19 Pandemic. Highlights on Medicine and Medical Science" Vol. 16 Chapter 13 Print ISBN: 978-93-91473-91-4, eBook ISBN: 978-93-91473-96-9. DOI: 10.9734/bpi/hmms/v16/9839D.*

4. *Mara, Duncan. 2017. "The elimination of open defecation and its adverse health effects: a moral imperative for governments and development professionals". Journal of Water Sanitation and Hygiene for Development.* ***7*** *(1): 1–12. doi:10.2166/washdev.2017.027. ISSN 2043-9083.*

5. *Misati, A. G., Ogendi, G., Peletz, R., Khush, R., Kumpel, E. 2017.* ***"****Can Sanitary Surveys Replace Water Quality Testing? Evidence from Kisii, Kenya". Int J Environ Res Public Health. 14(2): 152. Published online 2017 Feb 7. doi: 10.3390/ijerph14020152 PMCID: PMC5334706.*

6. *Mushi, D., Byamukama, D., Kirschner, A. K. T., Mach, R. L., Brunner, K., Farnleitner, A. H. 2012. "Sanitary inspection of wells using risk-of-contamination scoring indicates a high predictive ability for bacterial faecal pollution in the peri-urban tropical lowlands of Dar es Salaam, Tanzania". J. Water Health. 10:236–243. doi: 10.2166/wh.2012.117.*

7. *European Investment Bank. 2019. "On Water. European Investment Bank". European Investment Bank. doi:10.2867/509830. ISBN 9789286143199. Retrieved 2020-12-07.*

8. *Talabi, A. O., Ogundana, A. K. 2014. Bacteriological Evaluation of Groundwater In Ekiti-State, Southwestern Nigeria. International Journal of Scientific & Technology research volume 3, issue 9, pp. 288 – 293.*

9. *Bacci, F., Chapman, D. V. 2011. (Microbiological assessment of private drinking water supplies in Co. Cork, Ireland". J. Water Health.* ***9****:738–751. doi: 10.2166/wh.2011.053.*

10. *National Population Commission. 2006. "1963, 1991, and 2006 Census of Each Local Government Area of Ekiti State. Ado-Ekiti" National Population Commission, Ekiti State Chapter.*

11. *Talabi, A. O, T.ijani, M. N. 2013. "Hydrochemical and stable isotopic characterization of shallow groundwater system in the crystalline basement terrain of Ekiti area, southwestern Nigeria". Applied Water Science, 3:229–245.*

12. *Talabi, A. O.; Afolagboye O. L., Ademilua O. L. 2014. "Physical and Mechanical Properties of Rocks from the Archean-Proterozoic Terrain of Ado-Ekiti, South-Western Nigeria: implications on its groundwater potential". International Journal of advancement in Engineering, Management and Applied Sciences. 1(1): 2349-3224.*

13. *Dada, S. S., Briqueu, L. 1998. "Pb-Pb and Sr-Nd isotopic study of meta-igneous rocks of Kaduna: Implications for Archean mantle of Northern Nigeria". 32nd Annu. Conf. Nig. Min. Geosci. Soc., Abst. 57pp.*

14. *[14] Akinola, O. O., Talabi, A. O. 2012. "Petrochemical characteristics and geotechnical properties of crystalline rocks in the archean-proterozoic terrain of Ijero-Ekiti, southwestern Nigeria". RMZ – Materials and Geoenvironment, Vol. 59, No. 4, pp. 347–362.*

15. *Olusiji, S. A. 2013. "Geology and Structure of the Precambrian rocks in Iworoko, Are and Afao area, Southwestern Nigeria". International Research Journal of Natural Sciences. Vol.1, No. 1, pp.14-29.*

16. *Nwankwoala, H. O., Nwaogu, C., Bolaji, T. A., Uzoegbu, M. U., Abrakasa. S., Amadi, A. N. 2015. "Geochemistry and Quality Characterization of Effon Psammite Ridge Spring Water, Southwestern Nigeria". J Geol Geophys 4: 229. doi: 10.4172/2381-8719.1000229*

17. *Bayowa, O. G., Olorunfemi, M. O., Akinluyi, F.O., Ademilua, O. L. 2014. "Integration of Hydrogeophysical and Remote Sensing Data in the Assessment of Groundwater Potential of the basement Complex Terrain of Ekiti State, Southwestern Nigeria". Ife Journal of Science vol. 16, no. 3, 353 – 363.*

18. *Shemang, E. M. 1990. "Electrical depth soundings at selected well sites within the Kubani river basin, Zaria, Nigeria". Unpublished M.Sc. Thesis, A. B. U. Zaria. 108p.*

19. *Vandenberghe, J. 1982. "Geoelectric investigation of fault in Quartenary deposit". Geophysical prospecting, Vol. 30: pp. 879 – 897*

20. *Ako, B. D., Olorunfemi, M. O. 1989. "Geoelectric survey for groundwater in the Newer Basalts of Vom, Plateau State, Nig". Journal of Mining and Geology. Vol. 25. (1 and 2): pp. 247.*

21. *Oloruniwo, M. A., Olorunfemi, M. O. 1987. "Geophysical investigation for groundwater in Precambrian terrains: a case study from Ikare, Southwestern Nigeria". Journal of African Earth Sciences. Vol. 6(6): pp. 787-796.*

22. *World Health Organization (WHO). 1997. "Surveillance and Control of Community Supplies". World Health Organization; Geneva, Switzerland: Guidelines for Drinking-Water Quality.*

23. *Ilori, B. A., Adewumi, J. R., Lasisi, K. H., Ajibade, F. O. 2019. "Qualitative Assessment of Some Available Water Resources in Efon-Alaaye, Ekiti State Nigeria". J. Appl. Sci. Environ. Manage. Vol. 23 (1) 35–40. DOI: https://dx.doi.org/10.4314/jasem.v23i1.5*

24. *Oyedele, A. A., Ayodele, O. S. Olabode, O. F. 2019. "Groundwater quality assessment and characterization of shallow basement aquifers in parts of Ado Ekiti metropolis, Southwestern Nigeria". SN Appl. Sci.* ***1,*** *669. https://doi.org/10.1007/s42452-019-0683-1*

25. *Izobo-Martins, O., O. A. Dare-Abel, and Kunle Ayo-Vaughan. "Infrastructure conditions in public secondary schools, Ogun state, Nigeria." Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development 4.5 (2014): 17-25.*

26. *Akinnuli, BO, et al. "Decision Support System (Dss) for Domestic well-Water Treatment Plant Installation." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 9: 673-676.*
27. *Suganya, K., R. Velusamy, and S. Thiyageshwari. "Augmenting the Liquid Waste Management Skills of Rural Shg Women of Madurai District Through Eco-Wash Literacy." International Journal of Agricultural Science and Research (IJASR) 7.4 (2017): 359-362.*
28. *Rao, Yeluri Seshagiri, and Vanamali Dharma Rao. "Prevalence of Periodontitis among patients with Type-2 Diabetes Mellitus." Int J Gen Med Phrar, 5 (2), 15 22 (2016).*